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XLIV.—*Remarks upon the Memoirs on* Loxosoma.

By Oscar Schmidt [*].

When I was working in Naples in the winter of 1874–75, the good opportunity led me to what I may call a thorough investigation of *Loxosoma*. The points in which I had failed were most thoroughly brought home to me, immediately after the publication of my memoir, by Nitsche, the monarch of the Bryozoa. As a matter of course, I was convinced by him, in the first place, that *Loxosoma* belongs to *Pedicellina*, and, secondly, that my attempt to conceive of the gemmation as egg-development was not successful. My full acceptance of these main points is contained in the last edition of the 'Handbuch der vergleichende Anatomie' and in the new edition of the 'Thierleben,' Band x. p. 181. On the other hand, I have to refute a series of special statements of Nitsche's, some of them not unimportant. This appears to me the more necessary, as in the meanwhile the two detailed investigations of Vogt and Salensky have appeared, and Hatschek, in his memoir on the embryonic development and gemmation of *Pedicellina echinata* (Zeitschr. für wiss. Zool. Bd. xxix. 1877), has also referred to the developmental processes of *Loxosoma*. My remarks will therefore extend from Nitsche's preliminary communication on the structure and gemmation of *Loxosoma*

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[*] Translated by W. S. Dallas, F.L.S., from the 'Zeitschrift für wissenschaftliche Zoologie,' Band xxxi. (1878) p. 68.

Kefersteinii, Clap. (Zeitschr. für wiss. Zool. Bd. xxv. 1875), to Vogt's remarks upon Hatschek's memoir (*ibid.* Bd. xxx. 1878), and are intended, as far as possible, to reconcile the numerous contradictions contained in these works. They relate in part to the establishment of the species, in part to anatomy, and partly to the development of the buds—in the latter connexion furnishing the correction of an error into which Nitsche has fallen. I can, in fact, confirm by direct observation, what Hatschek supposed from theoretical grounds, that the ectoderm of the parent animal by no means furnishes the whole foundation of the bud.

The Species.—For the continuation of the investigation, which is very desirable, a criticism and comparative summary of the described species is above all things necessary. We do this in connexion with the annexed Table, in which the species are arranged in accordance with the number of tentacles, the development of the pedal gland, and the number of buds simultaneously developed.

LOXOSOMA *.	Tentacles.	Pedal gland of the adult animal	Buds on each side.	Lives upon	Locality.	Described in
1.**cochlear*, Schmidt, 1875.	8	developed.	1	Horny sponges.	Naples.	Arch. f. mikr. Anat. xii.; Thierl. 2te Aufl. x. p. 181.
2. *neapolitanum*, Kowalevsky, 1866.	10	developed.	1	*Phyllochætopterus.*	Naples.	Mém. Acad. St. Pétersb. x.
3.**pes* = *singulare*, Schmidt, 1875.	10	developed.	1	*Euspangia.*	Naples.	Arch. f. mikr. Anat. xii.
4. *singulare*, Keferstein, 1863.	10	0	1	*Capitella.*	St. Vaast.	Zeitschr. f. wiss. Zool. xii.
5.**tethyæ*, Salensky, 1877.	12	developed.	1	*Tethya.*	Naples.	Ann. Sci. Nat. 6^{e} sér. v.
6.**raja*, Schmidt, 1875.	12	developed.	1	Horny sponges.	Naples.	Arch. f. mikr. Anat. xii.
7. *phascalosamatum*, Vogt, 1877.	18	0	1	*Phascolosoma.*	Roscoff.	Arch. d. Zool. expér. v.
8.**crassicauda* (?), Salensky, 1877.	18	0	4	Annelid-tubes.	Naples.	Ann. Sci. Nat. 6^{e} sér. v.
9. *Kefersteinii*, Claparède, 1867.	20	0	4–6	*Zoobothryum*, *Acamarchis.*	Naples.	Ann. Sci. Nat. 5^{e} sér. viii.; Zeitschr. f. wiss. Zool. xxi., xxv., xxv. Suppl.

L. cochlear is not, as Vogt is inclined to think, a young state of *L. raja*, but a good species, never varying in the number of tentacles in the many hundred examples seen by me. The absence of a figure in my memoir in the 'Archiv für mikroskopische Anatomie' is now remedied by the figures on page 181 of my tenth volume of Brehm's 'Thierleben.'

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* The species marked with an asterisk are known to me by my own observations.

As my figure of *Loxosoma raja* is also true to nature, and the mature buds of the latter always already possess the full number (ten) of tentacles, and transitions were never observed by me, no further objection to the distinctness of these two species will probably be made.

L. neapolitanum must remain as it is until it has been rediscovered. I do not believe in the suctorial adhesive organs which Kowalevsky describes at the pedal extremity. At any rate it belongs to the forms with the pedal glands remarkably developed throughout life.

L. pes may be hereafter the name of the species in which I thought I recognized *L. singulare.* That this is not the case has been shown to be exceedingly probable by Nitsche. I should regard it as perfectly certain, if it were actually established that Keferstein's species possesses no pedal gland in the adult state. In the species found by me at Naples it is extraordinarily developed. The specific name is justified by the striking similarity of the form of the end of the stem to that of the human foot. It has only to be remarked that the true extremity, the point of the foot, is turned towards the dorsal surface of the animal.

L. singulare.—This species also requires a fresh investigation. Its distinctness with relation to the preceding species, or rather *vice versâ*, will no longer be doubtful if the atrophy of the pedal glands with advancing age be confirmed. According to Keferstein's figure, the stem ends in a disk. With regard to the buds he says, "In a specimen 4 millims. in diameter I saw on the outer integument an oval body measuring 0·04 millim. seated like a bud; and on the same specimen one measuring 0·2 millim. was attached to the outer integument by its stem-foot." As in the multigemmous species mature buds are never found without younger ones standing by their side, *Loxosoma singulare* will certainly belong to the species which push forth only one bud at time.

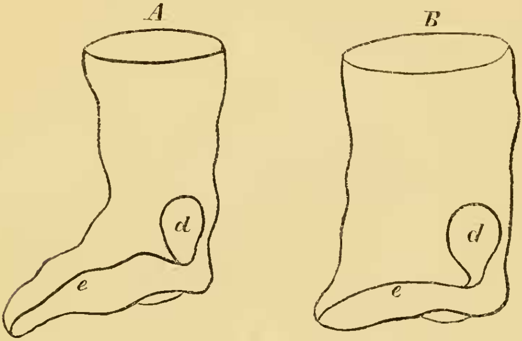
L. tethyæ has constantly twelve tentacles. The greatest breadth falls in the middle of the tentacular disk. The body narrows towards the peduncle, so that the walls of the stomach are closely embraced by the integuments of the body. A further peculiarity, overlooked by Salensky in consequence of the want of species for comparison, is the unusual length of the peduncle, which attains from four to six times the length of the body. I obtained in Naples a middle-sized *Tethya*, among the villosities of which some thousand of this *Loxosoma* were seated.

L. raja.—The outline of this species which I have given in my memoir is perfectly true to nature. Variations in the number of tentacles, which are already developed in their full number in the buds, scarcely occur, any more than varieties of the whole animal, which lives in innumerable multitudes in the passages of the horny sponges, often in company with *L. cochlear*.

L. phascolosomatum, in the form of the body and the length of the peduncle, comes next to *L. tethyæ*. It is distinguished therefrom by the number of tentacles, which, according to Vogt's statement, run up to eighteen in individual examples, while the ordinary number seems to be fourteen or sixteen. Vogt's figure (pl. xi. fig. 5) with fifteen tentacles is evidently founded upon a mistake, as is also the case with Claparède's figure of a *L. Kefersteinii* with thirteen tentacles (Zeitschr. f. wiss. Zool. 1874). As regards another (pl. xi. fig. 2) of my honoured Genevan friend's figures, I must admit, without prejudice to the unqualified recognition of his artistic preeminence, that I should see in it a sea-serpent rather than a female *Loxosoma*. On Vogt's assertion that his *Loxosoma* is of separate sexes we shall speak hereafter. Moreover I am not convinced of the disappearance of the pedal gland in the adult state. Of this we shall speak under the next species. Vogt has not stated on what *Phascolosoma* his species lives. I have from Naples a *Phascolosoma Strömii* beset with *Loxosoma*; the contractions produced by the alcohol prevent identification.

L. crassicauda.—Salensky made his observations in Naples in the summer of 1874, but only published them in the autumn of 1877. The present species is characterized by the numerous tentacles (as many as eighteen), the buds sprouting forth four on each side at the same time, and the disappearance of the pedal gland. Upon Salensky's remark that of the eighteen arms two are rudimentary (he shows seventeen arms in his fig. 1), no stress is to be laid, as in his fig. 10 we see all the eighteen arms completely developed. Upon its mode of occurrence its discoverer remarks, " *Loxosoma crassicauda* inhabits the tubercular shells of an Annelid of which I have been unable to determine the species." I think I can hardly be mistaken in regarding the unknown Annelid as *Phyllochætopterus socialis*, Clap.; and I further believe that Salensky, who witnessed the remarkable alteration in the form of the end of the peduncle during the transition of the bud into the adult condition, overlooked the retention of the gland. Thus, in the spring of 1877, when I was seeking in vain for *Loxosoma neapolitanum* upon *Phyllochætopterus socialis*, I found abundant specimens of another species, which I regarded as new until I obtained Salensky's memoir. The agreement is complete both in the figure and description, except as regards the pedal gland. Salensky says that his *Loxosoma crassicauda* belongs to the species in which the pedal gland, present in the buds, subsequently undergoes complete suppression. During my investigation of the first examples of the animal living on the tubes of *Phyllochætopterus* I was of the same opinion. The end of the peduncle of the adult form looks like the foot of of an elephant (fig. 1, B), whereas the buds of the same animal possess the well-marked human foot, carefully described by me in *L. pes* (fig. 1, A). The gland in the latter is exceedingly distinct; but in the mature peduncle it becomes indistinct only in consequence of the thickening of the integument and the usual adhesion of particles of dirt. It is present and of the same nature and extent as in the bud, but stands in a somewhat altered position relatively to the wall of the peduncle, as the figure shows: *d* is the gland, *e* the efferent duct. I am therefore convinced that Salensky has remained in the error into which I at first fell, and that *Loxosoma crassicauda* does not belong to the species with an aborted pedal gland. Judging from this instance, I think we are even justified in doubting whether this reduction of the pedal gland takes place in any of the described species.

Fig. 1.



L. Kefersteinii.—The doubt just expressed applies especially to this form. Of it Claparède has given only outline drawings from living objects without any details; whilst Nitsche's investigations were made only on material hardened in alcohol, and in part treated with osmic acid. As regards Claparède, who evidently occupied himself only *en passant* with *Loxosoma*, the overlooking of the pedal gland on his part would be very easily explained. As I have, moreover, made the observation on my preparations, that in the animals preserved by Nitsche's method the histological details often become very obscure, of which I shall hereafter adduce evidence, and that in most of the osmic-acid and alcoholic preparations of *L. pes* and the rest the gland is only recognizable with difficulty, I do not regard Nitsche's statement with regard to the absence of the pedal gland as decisive. If my supposition be confirmed that both *L. crassicauda* and *L. Kefersteinii* have pedal glands even when adult, or if it be proved that *both* of them have none, the sole, unimportant difference between them is the peculiar attachment of the buds of *L. Kefersteinii.* Whilst in all other species the pedal end of the bud is amalgamated with the body-wall of the mother, both investigators assert that in *L. Kefersteinii* this "Nabel" exists above the foot. I should here dispute this statement, which is by no means reconcilable with the development of the buds of the other species, if Claparède did not say of the animals observed alive, "The freely waving peduncles of the buds extend themselves in the most various directions."

Various other forms, described by others than the above-named authors, have been referred to the *Loxosomata*, and especially *Cyclatella annelidicola*, Van Ben. and Hesse. Vogt says justly that the figure is at the utmost a caricature of a *Loxosoma.* But the description also does not suit. Of the peduncle it is said, "the very *retractile* peduncle terminates in a *sucking-disk* ;" and this sucker is exactly like that of a Trematode. "The cilia of the appendages, in *constant movement*, are *all round* these appendages :" the words are quite irreconcilable with *Loxosoma* ; and as we cannot suppose that these distinct statements with regard to the simplest characters are fictitious, it seems to me that *Cyclatella* must no longer figure in the list of the *Loxosomata*, in spite of Van Beneden himself ('Schmarotzer,' p. 54). I have therefore felt no hesitation about placing *Cyclatella* in the same neighbourhood as before, as a Trematode-like animal (Thierleben, 2nd edit. p. 155).

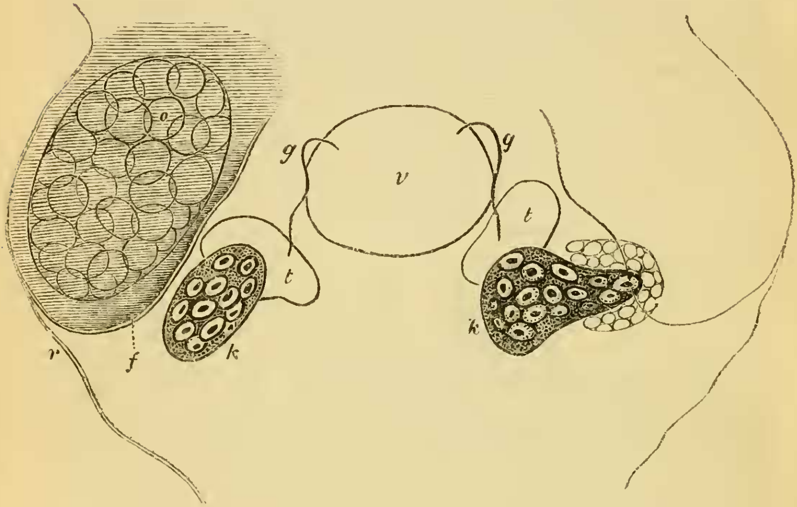
Anatomy.—The differences in the anatomical descriptions, by myself on the one hand, and by Nitsche and Salensky on the other, are not of much importance. Nitsche says that *Loxosoma* has no collar (*Ringkragen*) ; but it seems unmistakably, from my figure of *L. raja*, Vogt's of *L. phascolosomatum*, and Salensky's of *L. tethyæ* and *crassicauda*, not only that the simple tentaculiferous margin of the cup is constricted about the base of the infolded tentacles, but that a part occurring outside, close to the base of the tentacles, can be drawn over the tentacles as a hood.

With regard to parts which might be regarded as belonging to the nervous system, Nitsche and I have only put forth uncertain conjectures. It is otherwise with Salensky. He describes a central ganglion and a paired nerve running to a tuft of tactile setæ. He says, "The observation of the ganglion is very difficult, as it is hidden from the eye of the observer by the genital organs, and by different glandules situated in the middle of the body. I found it very difficult to discover the ganglion in adult animals already possessing genital organs; whilst this organ could be found without trouble in young individuals of which the genital organs were not developed." The figures (pl. xii. figs. 2, 3), however, show the ganglion in immediate contact with glandular bodies (*gs*), which, in my opinion, can be nothing but the testes; and in this connexion Salensky's ganglion looks exactly like the emptied seminal vesicle. I go still further, and cannot but compare the two large nerves described by Salensky to the ducts which lead from the seminal vesicle into the interior of the ovaries (see my Memoir, pl. ii. fig. 8). Here, therefore, new observations are necessary, and the more as my observations upon the reproductive organs, the only ones extant, are not complete.

Nitsche finds that by my statements upon these parts the agreement with *Pedicellina* is fully established. Both are hermaphrodite. It is, indeed, not unexampled that in an otherwise hermaphrodite genus there may be a species with separate sexes; and so Vogt's assertion that *L. phascolosomatum* is such a species would not be surprising in itself. But Vogt has not proved this. From his figures it appears only that he sometimes recognized the testes, sometimes the ovary, more distinctly, or that he has even confounded them.

According to the following figure I have to correct myself, so far as *Loxosoma pes* is concerned, only in one point. In the 'Archiv für mikroskopische Anatomie,' Bd. xii. Taf. ii. fig. 8, I represented two divisions of the testes, but in fig. 9 only one, on each side. With regard to this I find in my notes the remark, "in the lower division *t'* no mature semen." As I shall show more clearly below, I took the germ-cell layer or the bud-cell-stock for a part of the seminal gland, *k* in the figure. The error arose naturally from my referring the foundation of the bud to the ovary (*o*) lying above it. No efferent ducts from the seminal vesicle, except the funnels leading into the ovaries, are known to me; nor do I know the efferent ducts of the ovaries. Vogt gives the following account of the nature and action of the seminal vesicle of his supposed male *Loxosoma*:—"I observed a male, furnished with a bud of medium age, which showed me the ventral surface, and the seminal vesicle gorged with spermatozoids. While I was taking a sketch of it with the camera lucida the whole twisted packet of spermatozoids contained in the vesicle was suddenly expelled by a violent contraction of the entire animal. The packet slipped rapidly forward behind the peristome, and appeared free in the cavity of the vestibule between the tentacles. After a few minutes the animal closed the tentacular curtain with a jerk; the packet was then shot out into the water, and escaped my subsequent researches. After this expulsion the seminal vesicle, which was before so prominent, could only be distinguished with the greatest difficulty, it was so collapsed. As to the canal by which the seminal packet must have passed to reach the bottom of the vestibule, I found it impossible to distinguish it."

Fig. 2.



Reproductive organs of *Loxosoma pes*. *r*, margin of the body; *o*, ovary; *v*, seminal vesicle; *t*, testes; *g*, seminal ducts; *k*, bud-cell-stock; *f*, bud-pit.

I have cited this whole passage (which is supposed to prove that a transfer of the semen outside the body takes place by means of the water) because I can furnish a very simple explanation of it. As early as 1875 I observed (and the drawing and notes upon it are now before me), in *Loxosoma* *raja*, that in the buccal canal, in a shallow diverticulum or a sort of crop, the tough contents of the canal, which had not yet passed into the stomach, were collected into a ball, and gradually drawn out into the likeness of threads and twisted into a coil, *so that the complete ball presented a delusive resemblance to a packet of semen.* It seems to me certain that some such pseudoseminal ball, which was vomited forth by the animal in consequence of gentle pressure, led Vogt into error. Even when the animals were most roughly treated, I have never witnessed a rupture of the seminal vesicle, which is furnished with an exceedingly firm wall.

Gemmation.—I come now to the difficult question of the origin of the buds. I was very quickly convinced by Nitsche that my reference of this process to an egg-development was a misconception, although my numerous sketches always drove me back to seek in the foundation of the bud for something else than one or more cells of the skin. Nitsche declared "the most important result" of his investigation to be the definitive proof that the whole bud is formed from the ectoderm of the parent—a result which, when closely examined, was at least quite as remarkable as my assertion. Salensky has supported Nitsche, as also did Vogt previously. "The production of buds," he says, "only proceeds from the hypodermic layer"*. Nevertheless "this most important result" is erroneous; and as Nitsche finds my error partially explicable by my having been reminded of egg-development by the very remarkable formation of germ-layers, so I also believe that Nitsche would have been preserved from his mistake by the investigation of living material. At least *Loxosoma Kefersteinii* appears to me to be one of the species in which the position of the viscera renders the tracing of these conditions not impossible.

Whilst I was occupied in Naples, in the spring of 1877, with my renewed investigation of *Loxosoma*, and attained the result which will be mentioned immediately, Hatschek was tracing the gemmation of *Pedicellina* very carefully at Trieste. He referred the primitive germ-layers of the bud to the corresponding parts in the parent animal, in accordance with the observations made in other classes of animals, and declared himself to be in absolute contradiction to Nitsche, who derives the bud of *Loxosoma* from the single-layered ectodermal lamina of the parent animal. "I believe," he says, "that in the bud-forming region, which Nitsche represents as a single-layered cell-lamina, all the germ-layers are present just as in *Pedi-*

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* Repeated in Zeitschr. für wiss. Zool. Bd. xxx. 2, p. 377.

cellina, and will be referable to the germ-layers of the primary bud present in the larva." These so-called primary buds have been seen in *Loxosoma* by all observers; they are indicated by myself, Nitsche, and Vogt as genital foundations, by Salensky as "buds." They are very striking in *Loxosoma crassicauda*, and still more so in *L. pes*. The name "primary bud" cannot be suitable, as in no case are the germ-layers as such contained in them, nor is the mesoderm of the future bud preformed in them. The simplest and most appropriate expression still seems to me to be "germ-stock," in case there is any objection to speaking of a "bud-stock."

In the bud, the two bud-stocks, so soon as they have distinctly separated from the mesodermic material, are always united by a median bridge. This may disappear in the adult animal. This, however, does not always happen, as I have seen clearly in one case in *Loxosoma pes*. In most cases the mature bud-germ-stocks are separated (see fig. 2, *k*). In our species they are characterized by a finely granular mass intervening between the cellular elements; and this causes the whole organ to appear as if darkly pigmented. When one is once convinced of the identity of the primary foundation in the bud with the organ *k* of the adult, one can no longer regard it as a somewhat hypertrophied part of the ectoderm. To the left of my figure, seen from the ventral side, the stage is shown in which a bud has been set free and a new one is not yet commenced. We see the greatly developed fold of skin which covers the bud-pit or bud-cavity. In the extent of this fold, of the pit, and the whole depression thereby caused, the species vary much from each other. No exposure (*Freiliegen*) of the umbilicus of the bud, such as Claparède and Nitsche describe in *Loxosoma Kefersteinii*, is observed in any of the other species. In *L. raja* the sinus, in which almost the whole mature bud finds its place, is bowl-shaped; of course, as indeed my drawing shows, the inner angle of this bowl is covered.

On the right side of our figure we see the decisive stage in which the germ-stock has given off a process externally, which will separate and furnish the foundation of a bud. I will and can only affirm this fact, without deciding whether one or several cells separate from the germ-stock, and without being able to state what is the signification of the hood of pale indistinct cells which is seated upon the process of the germ-stock. As to the main point, *namely that the bud does not originate from one or more ectodermic cells of the mother*, there cannot well be any doubt. It will now also become intelligible how I was misled by similar but indistinct images to my first erroneous conception. Nitsche, who justly censures my "indefinite statements" as to the earliest developmental processes, has been no more fortunate himself; so that Hatschek also justly says of him, "Truly, with regard to the most important conditions (the earliest stages), Nitsche's statements also leave us in the lurch."

Probably, therefore, in my investigation of 1875, I saw rightly that a cell-material from the interior of the *Loxosoma* is employed in forming the bud, and must have been the more induced to assume an egg-development because a formation of germ-layers takes place such as had previously been observed only in the egg. Upon this circumstance my *collaborateurs* have not laid the emphasis that it deserves. We have to do either with an exceedingly remarkable inheritance and transfer from the egg-development to the bud-development, or with a convergence the mechanical causes of which must probably also throw light upon the process of true germ-layer formation.

Hatschek shows that in the larva of *Pedicellina* the foundation of the bud is thus produced: from the three germ-layers of the larva the materials of the germ-layers of the bud are in contact. There are divisions in which no germ-layer oversteps its own sphere; the resemblance to egg-development is not very close. Hatschek is inclined to suppose that something of the same kind occurs in *Loxosoma*, namely a so-called "primary bud" in the larva and bud, in the formation of which all the germ-layers take part. But this comparison cannot be carried out. The primary bud in *Loxosoma* is represented by the bud-stock, which originates solely from the mesoderm, and in this respect agrees with the true generative organs. The agreement of the gemmation with sexual reproduction, however, possibly goes much further, and approaches parthenogenesis if only one cell of the bud-stock is employed for each bud. If this were the case, which can be decided only by continued investigations, we should also have an explanation of the formation of germ-layers in gemmation.

Hatschek's hypothesis as to all the body-layers taking part in constituting the bud of *Loxosoma* springs from the desire to establish as completely as possible the homology with *Pedicellina*. At the same time *Loxosoma* appears, both to him and to other observers, to be the lowest type among the Entoprocta. For this very reason we may the more readily drop the first, untenable part of the hypothesis.

As regards the position of the bud in relation to the parent animal, I have expressed myself quite definitely. I say (*loc. cit.* p. 7) that the bud grows out *perpendicularly to the longi-*

tudinal axis, and (p. 9) that *the ventral surface of the embryo corresponds to the ventral surface of the parent*, and, further (p. 11), that the embryo adheres to the mother by the end of the peduncle. When, therefore, Nitsche complains that, owing to my inaccurate statements, orientation is not possible, he has certainly not been sufficiently careful. Vogt's reproach also, that my drawings are "plus que schématiques," is not correct. Certainly, as Vogt could discover in the younger buds no cells, but only amorphous sarcode masses, while *my figures give the most accurate outlines of the cells according to their form, number, and arrangement*, such as are to be found in none of the other memoirs, his statement is intelligible. My figures on plate iii. are therefore all concordantly oriented; and I do not merely appear to suppose, as Nitsche says, that in all the figures the upper and lower ends of the drawings are equivalent, but they are equivalent. If therefore, where my successors show a few indistinct cell-like bodies as the mesoderm, I, in my figures, show distinct cells coming together, and the mesoderm developing itself from the ectoderm before our eyes, I am bold enough to regard this as an excellence of my work.

Of the development of *Loxosoma* we at present unfortunately know only fragments. The complete series of observations which J. Barrois appears to have before him are still delayed in publication. My question whether the organs designated by *o* in my figure of the swarming larva (Taf. ii. fig. 25), repeated in the 'Thierleben' (p. 181, fig. *b*), are provisional eyes, I now retract. It seems to me more correct to suppose that these two dark ovate bodies are the bud-stocks, which appear so early in the bud.

XLV.—*On* Pharetronema zingiberis, *a new Genus and Species of Renierid Sponge.* By W. J. SOLLAS, M.A., F.G.S., &c.

[Plate XXX.]

Pharetronema zingiberis (mihi).

(Examined in the dried state.)

Sponge single, attached?, stipitate, in general form palmato-digitate or hand-shaped; stem short and compressed, widening about one inch above its base into an irregular palmate expansion, which is slightly curved from side to side and divides into a number of irregular cylindrical or com-